Injection molded microfluidic device for enrichment of somatic cells in cow milk

Jensen, Marie Pødenphant; Marie, Rodolphe ; Olesen, Tom; Matteucci, Marco; Kristensen, Anders

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Injection molded microfluidic device for enrichment of somatic cells in cow milk

Marie Pødenphant[a], Rodolphe Marie[a], Tom Olesen[b], Marco Matteucci[a], Anders Kristensen[a]

[a]DTU Nanotech, Technical University of Denmark, Ørsteds Plads building 345 east, Kongens Lyngby, Denmark
[b]Unisensor A/S, Gydevang 42, Allerød, Denmark

Dairy production is a large industry and the milk quality depends strongly on the animal health. Milk quality is measured by the total concentration of somatic cells (SCs), which concentration increases dramatically during an infection. However a quantitative monitoring of each somatic cell type would instead warn dairy farmers before milk quality is below standard and thus prevent waste of milk. Optical imaging of the SCs could allow such early diagnostics, but this is made difficult by the blur and contrast reduction due to fat particles and proteins found in milk. There is therefore a need for a continuous method for enrichment of somatic cells in milk.

Most of the fat particles are smaller than the SCs, and this size difference can be exploited to separate and enrich SCs from milk for further investigation. Pinched flow fractionation (PFF) is a continuous microfluidic size separation technique. It needs no external fields, making it simple and ideal for processing large samples with a passive microfluidic device. So far PFF devices have been used to separate polymer beads of different sizes [1][2], it has been used for detection of single nucleotide polymorphisms for genotyping [3], and it has been suggested to use it for separation of red blood cells from other blood constituents [4].

We have fabricated a PFF device by injection molding. Connected to a commercial pressure control system (Fluigent), the device separates particles with a size below and above a critical radius r_c in separate outlets. The device was used to separate SCs from smaller fat particles thus enriching the SCs and clarifying the sample. The solutions containing small and large particles were collected and screened for SCs using a cell counter (DeLaval). The separation was successful and 62.5% to 82.9% of the somatic cells went to the outlet for large particles while it was observed that most fat particles went to the outlet for particles smaller than r_c = 5 µm.

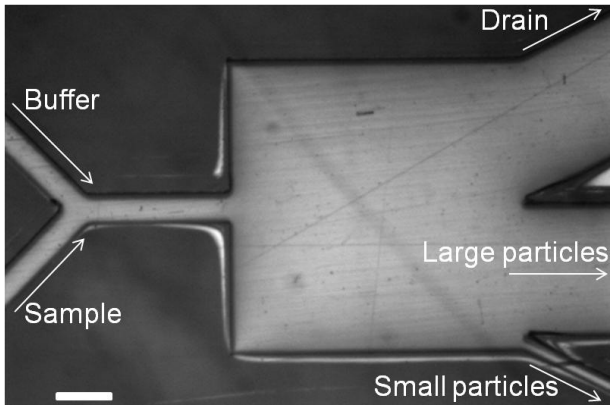

Figure 1: Top view of the PFF chip. The sample goes through one inlet and the cells are pinched against the sidewall because of flow from the buffer inlet. Cells/fat will follow streamlines depending on their size, and are separated into either the outlet for small particles or the outlet for large particles. The scale bar in the lower left corner is 200 µm.

Experiment number	SC count [%] Small particle outlet	SC count [%] Large particle outlet
1	17.1	82.9
2	37.5	62.5
3	29.8	70.2

Table1: Cell count measurements on samples collected from the outlets after separation.

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